July 29th to August 4th

IAAC Fab Lab Barcelona

Workshop Location: IAAC Fab Lab Barcelona Pujades street, 102

Workshop Team:

Tomas Diez, Fab Lab Director

Luciano Betoldi, Fab Academy Barcelona Alumni

Jesus Villarreal, Fab Lab Barcelona team

Day 1 Monday Morning 9:00 am

- Introduction to Fab Labs
- Introduction to IAAC and Fab Lab Barcelona Review the week: Describe final projects (inputs and outputs: motors, lights sound, temperature, etc.), tour of the Fab Lab Documentation and archiving online

Afternoon 4:00 pm

- Digital design (2D and 3D software tools)
- Homework: Decide upon and describe final project, integrating different fabrication methods and electronics

Day 2 Tuesday Morning 9:00 am

- 3D Scanning and file preparation for fabrication
- 2D Subtractive fabrication

Afternoon 4:00 pm

- 3D Additive fabrication
- DO T-shirts this afternoon as well

Day 3 Wednesday Morning 9:00 am

- Additive fabrication (removing parts from printers)
- Introduction to Precix and making large things

Afternoon 4:00 pm

- Precix /make something big Modela / molding and casting
- Fab Lab Management and Sustainability.

Day 4 Thursday Morning 9:00 am

- Electronics Example as a group
- Circuit Design
- File preparation & fabrication

Afternoon 4:00 pm

- Fab Lab Management.
- Recruiting people, lab sustainability
- Fabrication of individual Arduinos: components & soldering

Day 5 Friday Morning 9:00 am

- Programming circuits

Afternoon 4:00 pm

- Final Project Fabrication
- Systems Integration

Day 6 Saturday All morning 9:00 am Final Project Fabrication & Systems Integration Final Project Presentations - Barcelona probably around 19:00 (BCN TIME) Celebratory Dinner

Workshop Description

During this workshop we will be going over the basic skills needed to design, develop and fabricate almost anything in a fab lab.

Day One - During the first day we will be going over what can be considered the basics when attempting to develop a project in a fab lab, documenting your work and CAD.

Documenting is important not only for the person developing the project or idea but also for the entire fab lab community. Just as your own documentation will be helpful to you when attempting to replicate, improve on or convey your idea to others (or even yourself in the future!), it is also helpful to our members in that it will allow them replicate your idea (or parts of it) instead of spending time working on something that has already been developed by you.

This enriches the fab lab community and is very much a part of what makes this network different. On the other hand, this also means that you have access to other people's work, which may prove to be essential during this week as you start to learn about the basic process you will need to use to produce your Boot Camp project at the end of the week.

The second basic skill needed at the lab is the ability to transfer your design intentions into a CAD environment, be it in 3D (ideally) or in 2D. To do so, we will be using the Rhinoceros application (windows trial available to download here, ask us for mac the version) which we have found to be a great compromise between power and ease of use, as well as providing a gentle learning curve.

We will start working in 2D this week, as this is all that is necessary to start working with some of the simpler machinery in the lab, such as the laser and the vinyl cutters. We will than progress to 3D as needed and according to each persons abilities.

For day 2, you will need to prepare a small one paragraph text and accompanying images (whatever method you are comfortable with) to describe your proposed final project. Don't worry, this can change in the next couple of days as you learn more about what is possible and what peaks your interest.

Day Two - We will start this second day by demonstrating the use of the 3D scanning abilities of our 2 Roland Modela machines. These machines are not 3D scanners, but rather, small 2.5D milling machines that allow us to scan small objects with relatively high precision but relatively slow. This means that although these machines are available for you to use in the development and fabrication of your final projects you will need to asses weather or not they are the best solution for you, and if so, make sure you plan for plenty of time for this step of the process.

We will then move on the working with the laser and vinyl cutters, which are the most versatile machines we have in the fab lab inventory. The laser cutter can be used to precisely cut a veriety of materials from wood to a variety of polymers, to the point where a number of joints and fittings can be made to construct 3D objects form 2D files. Please be very attentive to the list of materials that can be cut with this machine. Using some none authorized materials in this machine could result in damage to the machine, or worse, poisonous gases that could be fatal to you and others.

The vinyl cutter can be used to cut, as the name implies, vinyl, for a variety of applications such as stencils and diagrams but more importantly, it can be used to cut thin copper into flexible and adhesive circuits.

The last of the processes we will look at on the third day is perhaps the most impressive of the technologies we have available, the 3D printers. In the Barcelona FabLab we have 4 different 3D printers, each with it’s own specific strengths and weaknesses. We could further divide these machines by open source and proprietary:

Open Source Machines:

RepRap: The original open source 3D printers, this machines allows us to print somewhat precise parts at a fraction of the cost of similar commercial machines with speed and a relatively large

build area.

Makerbot: This machine is a modified version of the RepRap, which trades in build area (which means you can only print relatively small objects) for ease of use. It is also quite fast compared to the commercial machines and has a resolution which is on the low end of the scale.

Commercial 3D Printers:

HP (Dimension) Designjet 3D: This machine uses the same principle as the Open source machines we have available, which is called FDM or fused deposition modeling. Basically, a thin plastic pipe is heated by the machine which then uses a nozzle to “draw” with the molten plastic the various layers of the object. The main differences between this printer and the open source machines are the following:

- Slower build time but with much higher resolution. - Heated chamber for a more uniform temperature, which translates into less warping of the parts. - More expensive material, means more expensive models. - Support Material means we can build in “thin air” but also means a second stage of production

where the support material is removed by another machine. Takes even longer.

Zcorp Z510: This machine is very different from our other machines, as it uses a completely different process commonly called ZPrint. This method uses a fine powder and a liquid binder (glue) to create the parts. A thin layer of powder is deposited on the build surface where the print head (much like an inkjet printer) draws each layer of the object using the binder. Once allowed to dry the binder will harden the powder it has come into contact with and form or final part. All the powder that has not become part of our model can be reused. The parts than have to go through one of two hardening process (depending on the final hardness we desire) and are only than ready. The machine is also able to print in full color and has the best resolution of all the

machines we have available.

Day three - At the start of day 3 we will be removing our 3D printed parts from the 3D printers (those of you that chose to use one of the commercial 3D Printers) and finishing our models either with the hardening procedure of the ZCorp of the cleaning procedure of the HP.

We will then move on to 3D milling on the Precix machine, once again using Rhinoceros, this time in conjunction with the RhinoCAM milling plugin. This milling machine allows us to cut large sheets of material (up to 3M by 1.5M) much like we can do with the laser cutter in a smaller scale, so many of the joints, fittings and techniques used to create 3D objects from 2D drawings and flat material stock is also possible on the Precix, but in this case we are able to use thicker materials as well as some other materials which cannot be cut in the laser cutter.

Added to this, we can also use this machine to mill 2.5D shapes onto thicker material stock such as foam. This allows us to create complex surfaces as well as molds for casting resins and other materials. This is similar to what the modela can achieve in a smaller scale, and that is precisely what we will be doing next, creating molds using either the modela and modelling wax as well as the Precix with foam.

We will than cast our parts using either a two part resin for the small scale molds and possibly concrete for the large molds.

Fab Lab Management session: How to become a Fab Lab? In this session we will cover all the aspects related to Fab Lab functionality, from the technical perspective to the different social approaches. Business models and project development will be part of this session, which aims to give participants an overview to the Fab Lab ecosystem.

Day four - From this point on we will move away from the mechanical side of the projects and into the electronics side of things. We will be using the Arduino prototyping platform for the

hardware side of the final projects as it is a tested platform which also has a lot of information, support and plugins available online through their network at arduino.cc. This platform also provides an easy to use software component, processing.

Arduinos can be purchased already assembled but part of our Boot Camp is learning how to design produce your own electronics so your first job will be to customize, edit and manufacture your own arduino, which you will then program the next day and later use in your final projects.

In order to do so, you will be provided with a schematic of our own customized version of arduino, which you will then edit and modify according to your needs using Eagle, and then mill and stuff (populate and solder the board) using FabTools and the Roland Modela.

For this you will need to translate the functions and behaviors of your intended project or object into a series of simple inputs and outputs. An input is basically data that your board will be able to collect and pass on to the processor (in our case the Atmel Atmega168) for processing and analysis and then pass on to the outputs so that they can represent of display your processed data. In this sense, an input can be almost anything, such as a database on a computer, a joystick or a temperature sensor.

In this exercise we will have several input devices available that can be integrated into our base arduino or fabduino design. We will work mostly with sensors such as temperature, humidity, light, pressure as well as some user controlled inputs such as buttons.

As far as outputs are concerned we will be working mainly with simple outputs such as LEDs (lights) several types of motors such as DC and stepper motors as well as simple actuators.

Day five - After successfully designing and producing your customized boards we will show you how to program your electronics to behave in the fashion desired for your final project.

We will be using the processing programming language, which for those of you who have a programing background, is somewhat similar to java and javascript.

For those with limited or no programing language, don't worry, it's easier than it appears and like has been mentioned before, there are very good resources online and examples that you can integrate as a starting point to your project. It may also be a good idea to go through some of the basic tutorials you can find online before the workshop, but don't worry too much if you don't get it, we will go through each project on a one-on-one basis during this session.

During the afternoon you will then have time to put all that you have learned in the previous days to use and produce whatever elements of your final design have not yet been finalized. During this time you will be able to use all of the machines and processes you have trained on during the week. Again we will be there to assist you and troubleshoot any problems you may encounter.

The last step will be for you to integrate all of the different mechanical and electronic components of your projects to create your final object/machine/device and get it ready for presentation on the last day of the Boot Camp, day 6.

Day six - The last day of the workshop will be dedicated to finalizing your projects ahead of the presentation which will take place at 7 o'clock in the afternoon.